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# IS 5210 (1995): High Impact Polystyrene Sheet [PCD 12: Plastics]

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# उच्च संघट्ट पालिस्टरीन शीट — विशिष्टि

( पहला पुनरीक्षण )

*Indian Standard*

# HIGH IMPACT POLYSTYRENE SHEET — SPECIFICATION

*( First Revision )*

First Reprint SEPTEMBER 2001

UDC 678·746 22·415

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**BUREAU OF INDIAN STANDARDS**
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 110002

*July* 1995 **Price Group 4**

Plastics Sectional Committee, PCD 12

## FOREWORD

This Indian Standard ( First Revision ) was adopted by the Bureau of Indian Standards, after the draft finalized by the Plastics Sectional Committee had been approved by the Petroleum, Coal and Related Products Division Council

Toughened polystyrene sheets which are available in a wide range of translucent and opaque colours are particularly used in forming processes This standard covers requirements and criteria essential for ensuring adequate control of quality Such data is not, however, necessarily suitable for design purposes

This standard was first published in 1969 In this first revision, requirements for high impact polystyrene extruded sheet having thickness above 3 5 mm and up to 6 0 mm have also been covered to meet defence requirements, whereas the earlier version covered sheet of thickness 0 5 mm to 3 5 mm only Material requirements have been modified in line with **IS 2267** 1994 'Polystyrene moulding and extrusion materials ( *second revision* )'

This standard contains clauses **4.2.1.1**, **4.2 2** and **4.4.2** and Note in Table 2, Note 1 under **4.9.3** and **5.1** which call for agreement between the purchaser and the supplier

For the purpose of deciding whether a particular requirement of this standard is complied with, the final value, observed or calculated, expressing the result of a test or analysis, shall be rounded off in accordance with IS 2 1960 'Rules for rounding off numerical values ( *revised* )' The number of significant places retained in the rounded off value should be the same as that of the specified value in this standard

# AMENDMENT NO. 1 MAY 2002
# TO
# IS 5210 : 1995 HIGH IMPACT POLYSTYRENE SHEET — SPECIFICATION

*( First Revision )*

[ *Page* 2, *Table* 1, *Sl No* (i) ]:

a) *Col* 2, *line* 2 — Substitute '*Max*' *for* '*Min*'

b) *Col* 3 — Substitute '5' *for* '4.0'

[ *Page* 2, *Table* 1, *Sl No.*(vii), *col* 3 ] — Substitute '0.10' *for* '0.30'

( PCD 12 )

Reprography Unit, BIS, New Delhi India

# *Indian Standard*
# HIGH IMPACT POLYSTYRENE SHEET — SPECIFICATION
## *( First Revision )*

## 1 SCOPE

This standard prescribes the requirements and the methods of sampling and test for high impact polystyrene extruded sheet of thickness 0.5 mm to 6.0 mm.

## 2 NORMATIVE REFERENCES

The following standards contain provisions which, through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision, and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated below:

| *IS No* | *Title* |
|---|---|
| 686 : 1985 | Method of determination of colour fastness of textile materials to daylight ( *first revision* ) |
| 2267 : 1994 | Polystyrene moulding and extrusion materials ( *second revision* ) |
| 2828 : 1964 | Glossary of terms used in the plastics industry |
| 4905 : 1968 | Methods for random sampling |
| 8543 (Part 4/ Sec 1) : 1984 | Methods of testing plastics : Part 4 Short-term mechanical properties, Section 1 Determination of tensile properties |
| 13411 : 1992 | Glass reinforced polyester dough moulding compounds (DMC) |
| 13360 (Part 4/ Sec 1) : 1995 | Methods of testing plastics : Part 4 Rheological properties, Section 1 Melt mass-flow rate (MFR) and the melt volume-flow rate (MVR) of thermoplastics |
| 13360 (Part 8/ Sec 1) : 1992 | Methods of testing plastics : Part 8 Thermal properties, Section 1 Determination of vicat softening temperature of thermoplastics materials |

## 3 TERMINOLOGY

For the purpose of this standard, the definitions given in IS 2828 : 1964 and the following shall apply.

### 3.1 High Impact Polystyrene

High impact strength material consisting of rubberized polystyrene with or without colourants and lubricants.

### 3.2 Reversion

Reversion is a measure of the degree of molecular orientation that remains in the sheet and which will influence its vacuum forming characteristics.

## 4 REQUIREMENTS

### 4.1 Material

The toughened polystyrene (rubber modified) materials used in the manufacture of the sheet shall be of grade designation PS 221 (natural colour) conforming to IS 2267 : 1994 and shall conform to the requirements given in Table 1.

### 4.2 Dimensions

**4.2.1** *Thickness*

The tolerance on thickness when measured at a temperature of 27° ± 2°C with a screw micrometer shall be as follows:

| *Thickness*, mm | *Tolerance* |
|---|---|
| From 0.5 to 2 | ± 0.10 mm |
| Over 2 to 6.0 | ± 5 percent |

**4.2.1.1** Tighter tolerance on thickness may be as agreed to between the purchaser and the supplier for specific applications.

**4.2.2** The tolerance on dimensions other than thickness shall be as agreed to between the purchaser and the supplier and in all cases there shall be no tolerance on the negative side.

### 4.3 Tensile Strength

The tensile strength of the test specimen shall be not less than 20.5 MPa (1 MPa = 10.2 kgf/cm$^2$) when determined by the method prescribed in IS 8543 (Part 4/Sec 1) : 1984.

### 4.4 Falling Weight Impact Strength

**4.4.1** The falling weight impact strength of the sheet shall be not less than the value given in Table 2 when determined by the method prescribed in Annex A.

**4.4.2** The minimum impact strength of sheets thicker than those given in Table 2 shall be as agreed to between the purchaser and the supplier and shall be determined by the method prescribed in Annex A.

### Table 1 Requirements for High Impact Polystyrene Material, Natural Colour
( *Clause* 4.1 )

| Sl No | Characteristics | Requirements | Method of Test, Ref to IS |
|---|---|---|---|
| (1) | (2) | (3) | (4) |
| i) | Melt flow rate (MFR) g/10 min at 200°C/5 kg, *Min* | 4.0 | 13360 (Part 4/Sec 1) : 1994 |
| ii) | Vicat softening point, °C, *Min* | 90 | 13380 (Part 8/Sec 1) : 1992 (Method B) |
| iii) | Heat distortion temperature °C, *Min* | | Annex H of IS 13411 : 1992 |
| | a) at 4.6 kg/cm$^2$ | 85 | |
| | b) at 18.6 kg/cm$^2$ | 70 | |
| iv) | Izod impact strength (Notched), kg cm/cm, *Min* | 8 | Annex E of IS 13411 : 1992 |
| v) | Tensile strength at break, kg/cm$^2$, *Min* | 220 | 8543 (Part 4/Sec 1) : 1984 |
| vi) | Elongation at break, percent, *Min* | 40 | 8543 (Part 4/Sec 1) : 1984 |
| vii) | Residual styrene percent by mass *Max* | 0.30 | Annex B of IS 2267 : 1994 |

### Table 2 Falling Weight Impact Strength
( *Clause* 4.4.1 )

| Nominal Sheet Thickness (mm) | Minimum Impact Strength J/m *Min* |
|---|---|
| 0.5 | 0.012 |
| 1.0 | 0.024 |
| 1.5 | 0.036 |
| 2.0 | 0.048 |
| 2.5 | 0.060 |
| 3.0 | 0.072 |
| 3.5 | 0.084 |
| 4.0 | 0.096 |
| 4.5 | 0.108 |
| 5.0 | 0.120 |
| 5.5 | 0.132 |
| 6.0 | 0.140 |

NOTE — The minimum impact strength of sheet thickness less than 0.5 mm or more than 6.0 mm shall be as agreed to between the supplier and the purchaser. For any thickness in between the given values, the value shall be calculated as 0.024 x thickness in mm.

**4.5 Finish of Sheet**

Both surfaces of sheet shall be of smooth appearance and free from defects such as lines and local depressions. The foil surface of the laminated sheet shall be free from delamination and free from other defects such as orange peel lines and local depressions.

**4.6 Colour Dispersion**

If the sheet is coloured, the colouring matter used shall be well dispersed and the surface of the sheet shall be free from colour streaks.

**4.7 Flexural Strength**

The flexural strength of the material shall be within the range of 44 to 55.5 MPa when tested as prescribed in Annex F of IS 13411 : 1992.

**4.8 Reversion**

The sheet shall not give reversion values exceeding 10 percent when tested as prescribed in Annex B.

**4.9 Colour Fastness**

For determination of colour fastness of the material either of the tests given in **4.9.1** and **4.9.2** may be used.

**4.9.1** *Daylight Exposure Test*

A specimen of the material when tested in Annex C shall be not inferior to that of No. 3 of the eight standard patterns of blue dye woollen fabric specified in IS 686 : 1985.

**4.9.2** *Accelerated Fading Test*

A specimen of the material shall withstand an accelerated fading test for at least 100 h without fading of the pigment when tested as prescribed in Annex D.

NOTES

1 There are certain shades which cannot stand 100 h accelerated fading test. In case such shades are required to be tested, duration of the fading test shall be subject to agreement between the purchaser and the supplier.

**2** In case of dispute the accelerated fading test shall be the referee method.

## 5 PACKING AND MARKING

### 5.1 Packing

The sheets shall be suitably packed as agreed to between the purchaser and the supplier

### 5.2 Marking

Each package and sheet shall be legibly marked with the following information

a) Indication of the source of manufacture, recognized trade mark, if any,

b) Dimensions of sheet,

c) Month and year of manufacture, and

d) Batch No or Code No

**5.2.1** When so specified by the purchaser, the direction of extrusion shall be indicated on each sheet

### 5.3 BIS Certification Marking

The sheets may also be marked with the Standard Mark

**5.3.1** The use of the Standard Mark is governed by the provisions of Bureau of Indian Standards Act, 1986 and the Rules and Regulations made thereunder The details of conditions under which the licence for the use of Standard Mark may be granted to manufacturers or producers may be obtained from the Bureau of Indian Standards.

## 6 SAMPLING

Representative samples of the material shall be drawn as prescribed in Annex E

# ANNEX A

( *Clauses* 4 4 1 *and* 4 4 2 )

## DETERMINATION OF IMPACT STRENGTH

### A-1 TEST SPECIMEN

**A-1.1** The specimen shall be a disc of 55 to 65 mm in diameter or a square piece of 55 to 65 mm The thickness of the specimen shall be the thickness of the sheet under test

### A-2 NUMBER OF SPECIMENS

**A-2 1** Twenty test specimens or more shall be used, if required No specimen shall be struck more than once

### A-3 APPARATUS

**A-3.1** A falling weight machine (*see* Fig 1) shows a suitable form of apparatus consisting essentially of the following parts

a) A heavy rigid base fitted with levelling screws

b) A specimen support in the shape of a hollow steel cylinder of internal diameter 50 00 ± 0 05 mm, minimum external diameter 57 mm and minimum height 25 mm The support is so fixed to the base that its axis coincides with the line of fall of the striker A soft shock absorbing disc approximately 6 mm thick is placed inside the cylinder and rests on the base

c) A rigid superstructure to carry the release mechanism and the guides for the weight carrier

d) A striker consisting of a 12 50 ± 0 05 mm diameter hardened steel ball rigidly attached to a weight carrier which will fall freely in the guides, and providing a hemispherical striking surface as shown in Fig 1

e) An appropriate set of weights which can be firmly attached to the carrier to give increments of 25 g

f) A plumb line at least 600 mm long to ensure that the guides are vertical

g) A release mechanism to give a free fall of 600 0 ± 2.5 mm to the surface of the specimen

**A-3.1.1** The machine shall stand on a rigid foundation

### A-4 CONDITIONING

**A-4.1** Condition the test specimens at 27 ± 2°C for not less than 3 h before testing and carry out the test at the same temperature

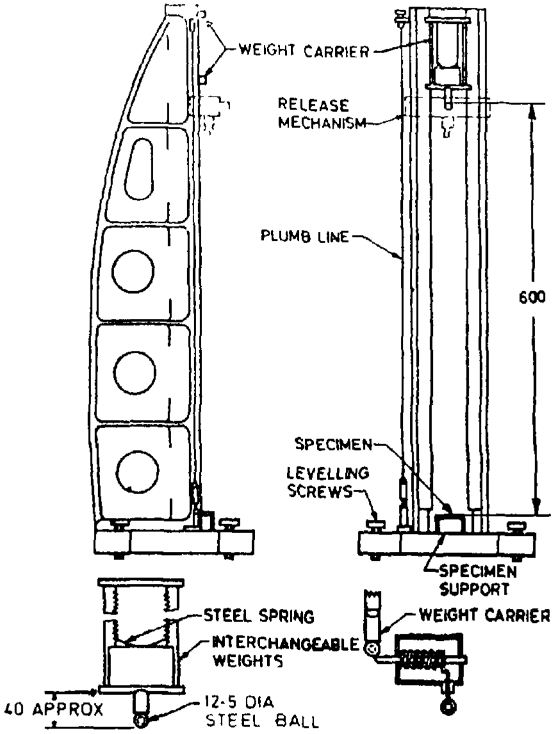
### A-5 PROCEDURE

**A-5.1** Place the specimen centrally on the specimen support. Specimens of thickness 0 90 mm or less shall be clamped in position

### A-5.2 Trial Run

Load the striker with weights so that the products of the height of fall and the combined weight of weights and striker is equal to the expected impact strength of the material under test Hold the striker in position by the release mechanism Operate the release mechanism so that the striker falls on to the specimen If the specimen is unbroken or cracked on one surface only it shall be recorded as unbroken If the specimen is broken or shows a crack or tear extending from one surface to the other, it shall be recorded as 'broken'

**A-5.2.1** If the specimen breaks, a second specimen shall be tested in accordance with the procedure



All dimensions in millimetres

FIG 1 FALLING-WEIGHT MACHINE

prescribed in A-5.2 but with an impact energy of S kgf.m less than that of the blow applied to the first specimen, where S is shown in Table 3. If the second specimen also breaks, a further specimen shall be tested in the same manner but with an energy S* kgf.m less than that of the blow applied to the second specimen. This sequence of operations shall be continued until a specimen does not break

**Table 3 Relationship Between Increment of Energy for Trial Run and Energy of Blow Immediately Preceding the Increment**

| Energy of Blow Immediately Preceding Increment, kgf.m | Increment (S) of Energy for Trial Run, kgf.m |
|---|---|
| (1) | (2) |
| Greater than 0.6 | Not less than 0.3 |
| 0.3 up to and including 0.59 | 0.15 ± 0.015 |
| 0.15 up to and including 0.29 | 0.07 ± 0.015 |
| 0.08 up to and including 0.149 | 0.03 ± 0.009 |
| 0.04 up to and including 0.079 | 0.02 ± 0.009 |
| Less than 0.04 | Not greater than 0.01 |

* During the trial run the value of S may vary in accordance with Table 2

**A-5.2.2** If the first specimen does not break, a second specimen shall be tested but with an impact energy S kgf.m greater than that of the blow applied to the first specimen. If the second specimen also does not break a further specimen shall be tested in the same manner but with an energy S kgf.m greater than that of the blow applied to the second specimen. This sequence of operations shall be continued until a specimen breaks

**A-5.2.3** The trial run comprises the first blow and subsequent blows preceded by an energy change of S kgf.m. The minimum number of blows in the trial run is two.

### A-5.3 Testing Run

After completion of procedure A-5.2.1 or A-5.2.2 as appropriate, the remaining specimens shall be tested, the energy of the blow applied to any specimen being T kgf.m less than that for the previous specimen if that specimen was broken, or T kgf.m greater if the previous specimen was unbroken, where T is as shown in Table 4.

**Table 4 Relationship Between Increment of Energy for Testing Run and Energy of Last Blow of Trial Run**

( *Clause* A-5.3 )

| Energy of Last Blow of Trial Run, kgf m | Increment (T) of Energy for Testing Run, kgf m |
|---|---|
| (1) | (2) |
| Greater than 0.6 | Not less than 0.15 |
| 0.3 up to and including 0.59 | 0.09 ± 0.015 |
| 0.15 up to and including 0.29 | 0.03 ± 0.009 |
| 0.08 up to and including 0.149 | 0.015 ± 0.004 |
| 0.04 up to and including 0.079 | 0.006 ± 0.003 |
| Less than 0.04 | Not greater than 0.003 |

**A-5.3.1** The testing run comprises the blows which are preceded by an energy change of 1 kgf m. The maximum number of blows in the testing is 18.

## A-6 CALCULATION

Impact strength

$$= \frac{1}{21 - m}(Y_{m+1} + Y_{m+2} + \dots + Y_{m+21})$$

where

$m$ = number of blows in the trial run,

$Y_{m+1}$ = impact energy of the first blow of the testing run,

$Y_{m+2}$ = impact energy of the second blow of the testing run to the second specimen following the trial run, and

$Y_{m+21}$ = impact energy of the twentieth blow decreased or increased by $T$ according to whether the specimen broke or did not break.

## A-7 REPORT

**A-7.1** The report shall state

a) the impact strength of the material,
b) the thickness of the test specimen,
c) whether the specimen was clamped or not,
d) the temperature of test when this is not as specified herein, and
e) the conditioning, if any, of the test specimens.

# ANNEX B

( *Clause* 4.8 )

## DETERMINATION OF REVERSION

## B-1 NUMBER OF SPECIMENS

**B-1.1** A set of five test specimens shall be cut in such a way as to sample the full sheet width.

## B-2 TEST SPECIMENS

**B-2.1** The specimens shall be a disc 100 mm in diameter or a square with 100 mm sides cut from the sheet. Circles 50.0 ± 0.25 mm in diameter shall be marked with a fine line concentrically on each face.

## B-3 PROCEDURE

**B-3.1** Place the specimen between two metal plates fixed at the appropriate distance apart given below. The plates shall overlap the specimen and leave a clear space of 12.5 mm all round its edge. Provisions shall be made to ensure that the specimen is retained between the plates.

| *Sheet Thickness* mm | *Plate Separation* mm |
|---|---|
| 4.8 | 9.5 |
| 4.8 to 6.4 | 12.7 |
| 6.4 to 9.5 | 19.0 |
| Over 9.5 | 2 to 3 times the thickness of the sample |

**B-3.2** Immerse the assembly for 15 ± 1 min in a bath of glycerol or polyethylene glycol (mol wt 400 to 600) maintained at 150 ± 2°C. Remove the assembly and immerse for not less than 5 min in water at room temperature. Take the specimen from the plates and measure the minor axes of the ellipses resulting from the marked circles on its faces to the nearest 0.5 mm (A, B).

NOTE — Provision shall be made for fume extraction over the bath.

## B-4 CALCULATION

$$\text{Reversion, percent} = \frac{100 - (A + B)}{100} \times 100$$

## B-5 REPORT

**B-5.1** The arithmetic mean of the results obtained for the five test specimens shall be taken as the reversion of the material.

# ANNEX C

(*Clause* 4.9.1)

## DETERMINATION OF COLOUR FASTNESS TO LIGHT

### C-0 GENERAL

### C-0.1 Outline of the Method

Colour fastness to light is determined by subjecting the test specimens along with standard wool samples to ultraviolet light and then examined for change in colour.

### C-1 APPARATUS

### C-1.1 Light Source

An artificial light source of the carbon arc type.

### C-2 PROCEDURE

**C-2.1** Place a specimen of suitable dimensions along with a set of wool standards as specified in IS 686 : 1985 at a distance of 250 mm from the carbon arc lamp. Protect half the portions from light by covering the specimens with aluminium foil. Maintain the temperature of the atmosphere surrounding the specimens throughout the period of exposure between 25 to 50°C. The specimen shall be exposed to the artificial light source for a minimum length of time to cause a change in the colour of the specimen corresponding to Grade 3 on Geometric Grey Scale as specified in IS 686 : 1985.

### C-2.2 Report

The colour fastness shall be reported as the number of the particular standard pattern the colour of which has changed to the same extent as the specimen.

# ANNEX D

(*Clause* 4.9.2)

## ACCELERATED FADING TEST

### D-0 GENERAL

### D-0.1 Outline of the Method

The sample is exposed to the carbon arc in fadometer for stipulated period and examined for fading of colour cracking.

### D-1 APPARATUS

### D-1.1 Fadometer

It shall consist of the following.

**D-1.1.1** *Source of Light*

A carbon arc composed of carbon electrodes and enclosed in a heat-resisting glass globe to produce a complete spectrum from 270 to 2 000 m. The arc operates on a direct current of approximately 11 to 13 A or an alternating current of 50 to 60 c/s and approximately 13 to 17 A with 110 to 140 V across the arc.

**D-1.1.2** The test specimens are hung vertically in a test racks on the inner wall of a cylinder (rotating or fixed type) concentric with the arc. The distance of the test specimen shall be approximately 250 mm from the arc. No part of the specimen shall be more than 100 mm above or below the horizontal plane passing through the centre of the arc when it is fitted with new electrodes.

**D-1.1.3** The air inside the chamber is humidified by placing water in a trough or water soaked cotton wicks in the chamber. A fan or blower unit keeps a flow or fresh air over the specimens and through the chamber.

**D-1.1.4** A black panel thermometer placed in a crack in the chamber shall not record a temperature more than 74°C.

### D-2 PROCEDURE

**D-2.1** Place a specimen of suitable dimension (cut at random from any portion of the film or sheet) at a distance of 250 mm from the carbon arc of the fadometer. Expose the specimen to the radiation for 100 h. Maintain the temperature of circulating air at about 54°C during the test. After the exposure, allow the specimen to cool for about an hour and bend it over a glass rod of 3 mm in diameter. Examine the specimen for signs of cracking, tackiness of fading of colour as compared with a blank unexposed sample.

# ANNEX E

( *Clause* 6 )

## SAMPLING OF HIGH IMPACT POLYSTYRENE SHEET

### E-1 SCALE OF SAMPLING

**E-1.1 Lot**

In a single consignment all the sheets of identical dimensions belonging to the same batch of manufacture shall be grouped together to constitute a lot.

**E-1.2** For judging conformity to the specified requirements each lot shall be considered separately.

**E-1.3** The number of sample sheets from a lot for determining the conformity shall be in accordance with col 1 and 2 of Table 5.

**E-1.4** The sample sheet shall be taken at random from the lot. In order to ensure randomness of selection, random number tables may be used (*see* IS 4905 : 1968 also)

**Table 5 Number of Sample Sheets**

( *Clause* E-1.3 )

| Number of Sheets In a Lot $N$ | Number of Sample Sheets $n$ |
|---|---|
| (1) | (2) |
| Up to 25 | 1 |
| 26 to 150 | 2 |
| 151 to 300 | 3 |
| 301 to 500 | 4 |
| 501 and above | 5 |

### E-2 NUMBER OF TESTS AND CRITERIA FOR CONFORMITY

**E-2.1** Each of the sample sheets selected according to E-1.3 shall be tested for all the requirements of this specification. The lot shall be declared to be in conformity if each sample sheet individually meets the specified requirements.

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This Indian Standard has been developed from Doc No PCD 12 (782)

**Amendments Issued Since Publication**

| Amend No | Date of Issue | Text Affected |
|---|---|---|
| | | |
| | | |

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